VIA MEDICA

CASE REPORT

Folia Morphol.
Vol. 65, No. 4, pp. 396–399

ISSN 0015–5659
www.fm.viamedica.pl

An atypical position of the foramen ovale

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[Received 19 April 2006; Revised 3 August 2006; Accepted 3 August 2006]

*Visual inspection of a dry adult human skull revealed absence of a typical foramen ovale on the left side of the cranial base. The region of the foramen ovale was covered by an osseous lamina, which was continuous with the lateral pterygoid plate and thus formed a wall of an apparent canal, which opened on the lateral side of the pterygoid process. This canal is referred to as an oval canal (*canalis ovalis*), instead of the foramen ovale. It runs superiorly, medially from the infratemporal fossa, and opens into the middle cranial fossa. The altered osseous morphology of this basicranial region may affect the course of the neurovascular structures which pass through the foramen ovale. As a consequence, clinical symptoms could occur, including paresthesiae of the inner aspect of the cheek and compression and neuralgia of the mandibular nerve or its branches.*

Key words: foramen ovale, oval canal *(canalis ovalis)*, sphenoid bone

INTRODUCTION

The sphenoid bone contains numerous foramina and fissures, which accommodate several vessels and nerves. One of these is the foramen ovale, which serves as a passage for the mandibular nerve, accessory meningeal artery and the lesser petrosal nerve. Normally the foramen ovale is located in the greater wing of the sphenoid bone, posterior and lateral to the foramen rotundum [9, 13]. Occasionally, the foramen ovale can be covered by the bony laminae or bridges, which result from ossification of the ligaments that are stretched between the lateral pterygoid process and the sphenoid spine [2, 5, 10]. Not only is the foramen ovale important in functional cranial anatomy, but it also has a practical significance in neurosurgery, as it enables access to the trigeminal nerve. Thus knowledge of its position is clinically important in the event of anaesthesia of the mandibular nerve.

Information on the morphological variants of the foramen ovale in humans is somewhat sparse in literature, and therefore we have decided to contribute a case description of this anomaly. The aim of this study is to present an anatomical variant of the unilaterally altered topography and morphology of the foramen ovale in a human skull.

MATERIAL AND METHODS

During visual inspection of the cranial collection housed in the Department of Anatomy of the Jagiellonian University in Cracow a skull was found with an atypical position of the foramen ovale. The date and origin of the skull are unknown. However, its morphological appearance allows it to be attributed to a European population and moderately expressed cranial traits rule out a prehistoric origin. The skull was therefore regarded as a contemporary specimen. It is well preserved, with no noticeable deformities. The marked muscular bone attachments, strongly developed temporal lines, large mastoid processes and prominent supercilliary ridges are characteristically male.

A routine anatomical and morphometric study was performed on the skull to assess the atypical character of the locally changed morphology within

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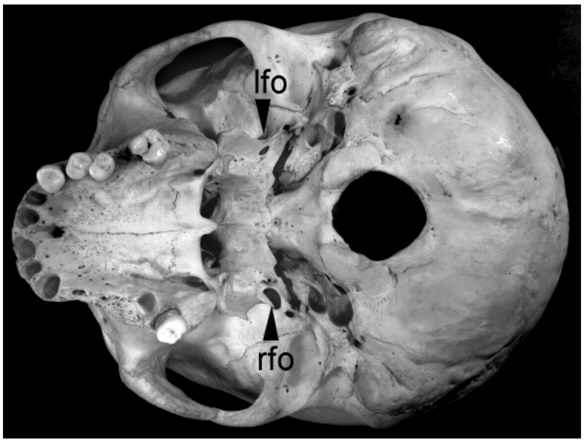

Figure 1. Basicranium of the examined skull; rfo — right foramen ovale, lfo — left foramen ovale (covered by the bony lamina forming the medial wall of the apparent oval canal (*canalis ovalis*).

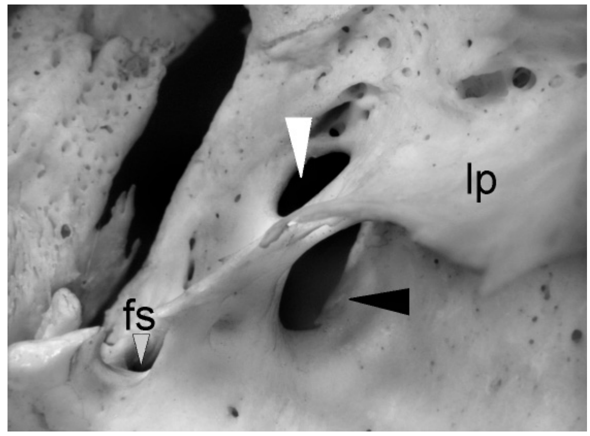

Figure 3. Magnification of the inferior view of the foramen described. The black arrow indicates the lateral compartment (oval canal; (*canalis ovalis*) and the white arrow indicates the medial compartment of the apparent foramen ovale; fs — foramen spinosum, lp — lateral pterygoid.

the region of the left foramen ovale and the neighbouring osseous structures. Measurements of the size of the foramen under investigation were performed using a sliding digital calliper.

RESULTS

Visual inspection of the cranial base revealed an atypical left foramen ovale, whereas the right foramen ovale was well visible and normally developed (Figs. 1, 2). In this case the normal site of a singular foramen ovale was divided by the bony lamina into two compartments, a medial (lesser) and a lateral, which was considerably larger. It appeared that the medial compartment constituted a foramen, which could be regarded as a topographic counterpart to the foramen ovale proper. The lumen of the medial compartment lay in the plane of the basicranium. It ran nearly perpendicular to the oval canal (*canalis ovalis*) (lateral compartment) and opened in the middle cranial fossa. The medial compartment was bounded laterally by the inconstant bony lamina, which should be regarded as the pterygoalar bar. The osseous rim, part of the greater sphenoid wing, limited the rest of this compartment (Fig. 3).

The lateral portion contained a much larger foramen. This was located close to the root of the pterygoid process, within the medial part of the infratemporal surface of the greater wing of the sphenoid bone (Fig. 4). This foramen was continued

Figure 2. Lateral view of the skull investigated with removed mandible. The arrow indicates the outlet from the canal as a substitute for the typical foramen ovale.

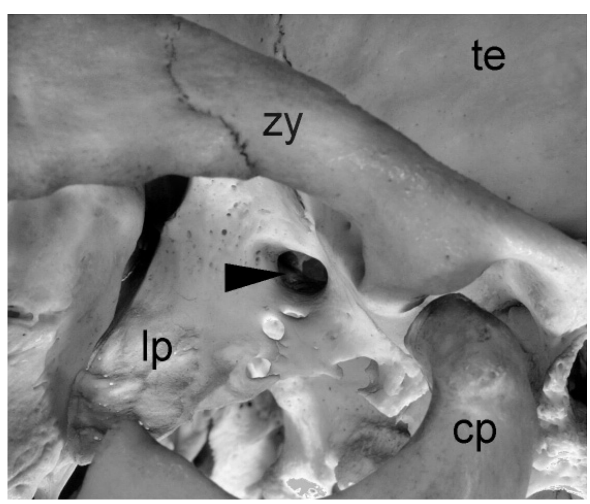

Figure 4. Close-up view of the left infratemporal fossa. The black arrow indicates the outlet from the apparent foramen ovale (canal); te — temporal bone, zy — zygomatic process, lp — lateral pterygoid, cp — condylar process.

with a canal that passed upwards, medially, and finally opened into the middle cranial fossa. The canal can be referred to as the oval canal_ (*canalis ovalis*) and in this case should be regarded as a substitute for a typical foramen ovale because of its considerable size (it provided enough space for passage of the mandibular nerve) and communication with the middle cranial fossa. The opening of the canal was elliptical in shape and its size was measured as 6.8 mm × 4.4 mm. However, its diameter fell within the normal range of variation of the foramen ovale (min: 5 mm × 2 mm, max: 8 mm × 7 mm), as cited in literature [1, 3].

Hence the lateral pterygoid process is pierced by three small accessory foramina. These appeared to be located at the fusion between the posterior edge of the lateral pterygoid plate and a bony plate, which constitutes the wall of the *canalis ovalis*. These foramina are arranged in a row along the outlet from the aforementioned canal (Fig. 4).

DISCUSSION

The skull investigated shows altered anatomy of the sphenoid bone because of atypical organisation of the foramen ovale. The region of the basicranium, which is normally pierced by the foramen ovale, was occluded in our case by a bony lamina rising from the medial aspect of the lateral pterygoid plate. This atypical basicranial morphology can be attributed to variation in the pterygoid process and ossification of the ligaments that are stretched between components of the sphenoid bone. During development the foramen ovale is located within a membranous bone derived from a medial pterygoid process. A lateral extension of the membranous bone, followed by its ossification, may produce a bony plate (the pterygoalar bar) on the margin of the foramen [4].

The pterygoalar bar extends as a bony lamina from the root of lateral pterygoid lamina to the greater wing of the sphenoid bone. It may lie along the lateral or medial margin of the foramen ovale or cross the lumen of the foramen ovale [12]. Although the pterygoalar bar exists in some skulls, the foramen ovale usually occupies its typical position. In this study we observed a peculiar relationship between these two structures, as the pterygoalar bar extended behind the whole atypical foramen ovale, which pierces the lateral pterygoid process. In the inferior view this foramen is located laterally both to the lateral pterygoid process and its bony caudal extension, the pterygoalar bar. Therefore we are not inclined to the view that in this case the bony bar divides the foramen ovale into two separate parts. A small elliptical foramen, which is visible on the medial aspect of the pterygoalar bar, should be regarded as a distinct entity and different from that present on the lateral aspect of the right pterygoid process.

In rare cases ossification of the pterygospinous ligament may also produce a bony bridge (the *lamina pterygospinosae*) that extends in the vicinity of the foramen ovale. The bridge may run over the foramen ovale medially or laterally to its rim [11]. However, in such cases the foramen ovale is preserved as a singular whole and occupies a normal position in the basicranium (posterior to the root of the pterygoid process). In our case the foramen ovale has not kept its typical position, as its opening faces laterally instead of vertically.

Krmpotić-Nemanić et al. [8] described an opening in front and medial to the foramen ovale, which leads to an oblique canal directed towards the fossa pterygoidea. The canal was up to 2.3 mm long and opened near the root of the pterygoid process. They termed this opening the "*foramen ovale accessorium*", and it was found in 48 of 124 anatomical specimens. Accessory foramina were also observed in the skull investigated by us, but they accompanied the outlet from the so-called oval canal (*canalis ovalis*) instead of a typical foramen ovale.

An atypical position of the foramen ovale and neighbouring osseous structures could influence the anatomical organisation of the nerves that run through this opening. Thus the main trunk of the mandibular nerve was redirected more laterally and its divisions (lingual nerve and inferior alveolar nerve) had to cross the extended lateral pterygoid plate. Because of the abnormal course it would be possible for the nerves to become entrapped or compressed between osseous structures and muscles, causing neuralgia.

The oval canal (*canalis ovalis*) divided into two compartments by extension of the lateral lamina of the pterygoid process, as here observed, is a great rarity. Each of these compartments appeared to transmit part of a mandibular division of the trigeminal nerve. The question remains as to how they could pass through the canal. The medial compartment could contain the lingual nerve, buccal nerve and the nerve to the medial pterygoid muscle, while the nervus spinosus had to run through the foramen spinosum, as this existed in the skull studied.

Elongation of the lateral lamina of the pterygoid process could result in weakening of the medial pterygoid muscle and paresthesiae of the inner aspect of the cheek. Probable compression of the lingual nerve could lead to a weakening of taste transmission from the taste buds located on the anterior 2/3 of the tongue unilaterally. It is also possible that all the nerves mentioned could have been affected by neuralgia [6, 7].

Information on foramina variants of the human skull gives insight into associations between neurovascular anatomy and cranial morphology. Certainly the sphenoid bone, because of its complex structure and intricate embryological origin, should be studied in different anatomical aspects, including its normal and abnormal variation. This bone accommodates numerous vessels and nerves, which can easily be entrapped in the case of development of accessory osseous structures or calcification of the intrinsic ligaments.

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